AMENDMENTS TO THE SPECIFICATION

Please replace the present title with the following amended title:

IMAGE RETRIEVAL METHOD

BASED ON COMBINATION OF COLOR AND TEXTURE FEATURES

Please replace the first full paragraph appearing on page 7 of the specification with the following amended paragraph:

In step (a2), the texture distance between each color vector of each region of the query image and each color vector of each region of each data image may be calculated using:

$$d_t(I_1, I_2) = \sum_{i=1}^{N}\sum_{j=1}^{M}\left|\frac{m_{1ij} - m_{2ij}}{\sigma(m_{ij})}\right| + \sum_{i=1}^{N}\sum_{j=1}^{M}\left|\frac{\sigma_{1ij} - \sigma_{2ij}}{\sigma(\sigma_{ij})}\right|.$$

<u>where $\sigma(m_{ij})$ is the standard deviation of the mean value for a color vector for a region of the i-th frequency channel and j-th orientation channel, and where $\sigma(\sigma_{ij})$ is the deviation of the standard deviation of the color vector for a region of i-th frequency channel and the j-th orientation channel.</u>

Please replace the second paragraph beginning on page 7 of the specification with the following amended paragraph:

Preferably, step (pa-2) comprises: (pb-1) obtaining a grid map of the query image and each data image; and (pb-2) obtaining a texture sample of a desired size for each region based on the grid map. In this case, step (pb-1) may comprise: (pb-1-1) taking a rectangle $M(i, j)$ having

largest side lengths for a sample region, where $0 \leq i \leq n$ and $0 \leq j \leq m$; (pb-1-2) dividing the rectangle $M(i,j)$ into sub-rectangles each having a $l \times l$ size; and (pb-1-3) obtaining a grid map for the sample region using a predetermined function

$$M_{grid}(i,j) = \begin{cases} 1 & if\ p_{ij}(x,y) \subset I_k\, for\, \forall\,(x,y) \\ 0 & otherwise \end{cases}$$

which outputs 1 if all the divided grids belong to the sample region, and otherwise, outputs 0, the predetermined function expressed by:

where $0 \leq i \leq \left[\frac{n}{l}\right] - 1$ <u>(where [n/l] is a result of applying a floor function)</u>, $0 \leq j \leq \left[\frac{m}{l}\right] - 1$ <u>(where [m/l] is a result of applying a ceiling function)</u>, $0 \leq x \leq l-1$, $0 \leq y \leq l-1$, and $p_{ij}(x,y)$ is a point that belongs to rectangle $M(il+x,\ jl+y)$. Preferably, after step (pb-1-3), the image retrieval method further comprises: (pb-1-4) transforming the grid map obtained in step (pb-1-3) to a grid distance map by repeating computations with:

$$\{M^d_{grid}(i,j)\}_0 = M_{grid}(i,j),\ and$$

$$\{M^d_{grid}(i,j)\}_n = \min(\{M^d_{grid}(i,j-1)\}_{n-1}, \{M^d_{grid}(i-1,j)\}_{n-1}, \{M^d_{grid}(i,j+1)\}_{n-1}, \{M^d_{grid}(i+1,j)\}_{n-1}) + 1,$$

$if\ \{M^d_{grid}(i,j)\}_{n-1} = \{M^d_{grid}(i,j)\}_n, M^d_{grid}(i,j) = \{M^d_{grid}(i,j)\}_n$, and

(pb-1-5) performing region growing in every direction from a seed of the grid map, which has the largest distance in the grid and is expressed by $(a,b) = \underset{(i,j)}{\arg\max}\,\{M^{d}_{grid}(i,j)\}$, to satisfy the relation $M^{d}_{grid}(i,j) > 0$ until the maximum area rectangle is extracted.

Please replace the first full paragraph appearing on page 11 of the specification with the following amended paragraph:

In the image retrieval method, step (b-2) may comprise projecting the color and texture distances onto a 1-dimensional distance space using:

$$d(I_q,I_1) = W_c d_c(I_q,I_1)\left(1+\frac{2}{\pi}\tan^{-1}\frac{d_t'(I_q,I_1)}{d_c(I_q,I_1)}\right) + W_t d_t'(I_q,I_1)\left(1+\frac{2}{\pi}\tan^{-1}\frac{d_c(I_q,I_1)}{d_t'(I_q,I_1)}\right)$$ where

$$\left[W_c = \frac{\varpi_c}{\varpi_c+\varpi_t}\text{, and } W_t = \frac{\varpi_t}{\varpi_c+\varpi_t}\right]$$ where $W_c = \frac{w_c}{w_c + w_t}$ and $W_t = \frac{w_t}{w_c + w_t}$

.

Please replace first paragraph on page 18 of the specification with the following amended paragraph:

A distance function for two image regions based on their texture vectors is expressed as:

$$d_t(I_1,I_2) = \sum_{i=1}^{N}\sum_{j=1}^{M}\left|\frac{m_{1ij}-m_{2ij}}{\sigma(m_{ij})}\right| + \sum_{i=1}^{N}\sum_{j=1}^{M}\left|\frac{\sigma_{1ij}-\sigma_{2ij}}{\sigma(\sigma_{ij})}\right|.$$

where $\sigma(m_{ij})$ is the standard deviation of the mean value for a color vector for a region of the

i-th frequency channel and j-th orientation channel, and where $\sigma(\sigma_{ij})$ is the deviation of the standard deviation of the color vector for a region of i-th frequency channel and the j-th orientation channel.

Please replace paragraph beginning on page 19 of the specification with the following amended paragraph:

FIG. 6 shows an example of taking a texture sample from an image region. In this step, the texture sample is obtained using the gray image and a map of a sample region. Referring to FIG. 6, a grid map for the sample region is obtained to take a texture sample (Step 602). In particular, a rectangle $M(i,j)$ (where, $0 \leq i \leq n$ and $0 \leq j \leq m$), which has largest side lengths, is taken from the sample region. Next, the rectangle $M(i,j)$ is divided into sub-rectangles each having a $l \times l$ size. Then, a grid map for the sample region is made with the following predetermined function, which outputs 1 if all the divided grids belong to the sample region, and otherwise outputs 0:

$$M_{grid}(i,j) = \begin{cases} 1 & if\ p_{ij}(x,y) \subset I_k\, for\, \forall\,(x,y) \\ 0 & otherwise \end{cases} \qquad ...(9)$$

where $0 \leq i \leq \left[\frac{n}{l}\right] - 1$ (where [n/l] is a result of applying a floor function), $0 \leq j \leq \left[\frac{m}{l}\right] - 1$ (where [m/l] is a result of applying a ceiling function), $0 \leq x \leq l-1$, $0 \leq y \leq l-1$, and $p_{ij}(x,y)$ is a point that belongs to rectangle $M(il+x,\ jl+y)$.

Please amend the formulas appearing on page 23 of the specification with the following amended formulas:

$$\underline{V_{m,k} = \frac{V_k - \mu_k}{3\sigma_k}} \qquad \underline{(15)}$$

$$\left[\, v_{m,k} = \frac{v_{m,k} - \mu_k}{3\sigma_k} \qquad \ldots(15) \right]$$

$$\underline{V'_{m,k} = \frac{V_k + 1}{2}} \qquad \underline{(16)}$$

$$\left[\, v'_{m,k} = \frac{v_{m,k} + 1}{2} \qquad \ldots(16) \right]$$

Please replace second full paragraph appearing on page 24 of the specification with the following amended paragraph:

The normalized color and texture vector distances are combined by the following function (18) by weighting the color and texture vector distances with weighting factors:

$$d(I_q, I_1) = W_c d_c(I_q, I_1)\left(1 + \frac{2}{\pi}\tan^{-1}\frac{d_t'(I_q, I_1)}{d_c(I_q, I_1)}\right) + W_t d_t'(I_q, I_1)\left(1 + \frac{2}{\pi}\tan^{-1}\frac{d_c(I_q, I_1)}{d_t'(I_q, I_1)}\right) \quad \ldots(18)$$

[where $W_c = \dfrac{\varpi_c}{\varpi_c + \varpi_t}$, and $W_t = \dfrac{\varpi_t}{\varpi_c + \varpi_t}$] $\underline{\text{where}}$ $\dfrac{w_c}{w_c + w_t}$ ______, an $\dfrac{w_t}{w_c + w_t}$ ___.

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

LISTING OF CLAIMS:

1. (currently amended): A method for retrieving a data image similar to a query image using a feature distance calculated by combining one or more weighted color distances and one or more weighted texture distances by considering human visual perception attributes,

wherein the one or more weighted color distances and the one or more weighted texture distances are obtained by applying predetermined weighting factor to each texture distance and to each color distance.

2. (currently amended): A method for retrieving a data image similar to a query image in an image database containing a plurality of data images, the method comprising:

(a) calculating a plurality of color distances and a plurality of texture distances between a query image and each data image in the image database;

(b) weighting each of the calculated color distances and texture distances with a respective predetermined first weighting factor;

(c) calculating a feature distance between the query image and each data image by combining the weighted color distances and the weighted texture distances by applying a second set of differing weighing factors that reflect ~~considering~~ human visual perception attributes; and

(d) determining the data image similar to the query image using the feature distance.

3. (original): The method of claim 2, before step (a), further comprising:

(pa-1) segmenting the query image and each data image into a plurality of first regions using a plurality of color features; and

(pa-2) determining a plurality of sample regions in the query image and each data image for extraction of a plurality of texture features.

4. (original): The method of claim 3, wherein step (a) comprises:

(a1) generating a plurality of color vectors of the first regions using the color features and calculating a plurality of color distances; and

(a2) generating a plurality of texture vectors of the sample regions using the texture features and calculating a plurality of texture distances.

5. (original): The method of claim 3, wherein step (pa-1) comprises quantizing a plurality of color vectors of the query image and each data image.

6. (original): The method of claim 5, wherein quantizing the color vectors comprises:

(pa-1-1) performing a peer group filtering on the query image and each data image for noise removal and smoothing effects; and

(pa-1-2) clustering a plurality of filtered pixel values of the query image and each data image using a generalized Lloyd algorithm.

7. (original): The method of claim 5, further comprising:

defining a J-value indicating a color uniformity in each pixel of a plurality of pixels of the query image and each data image, which have undergone quantization;

storing the J-value in each pixel of the query image and each data image to obtain a plurality of J-images;

segmenting each J-image into a plurality of second regions by a predetermined segmentation method;

repeating the segmentation of each J-image to obtain a map of one or more over-segmented regions for each J-image; and

obtaining a final map for each J-image by merging the over-segmented regions based on a correlation of color.

8. (original): The method of claim 7, further comprising indexing a feature vector space by a representative color and a percentage of the representative color in each second region.

9. (original): The method of claim 6, wherein step (pa-1-2) comprises applying a predetermined algorithm to increase the number of resulting clusters or to merge the resulting clusters.

10. (original): The method of claim 4, wherein the color features are expressed by a color feature descriptor $f_c(I_k)$ with a representative color vector and a percentage of the representative color vector for each first region.

11. (currently amended): The method of claim 10, wherein the color feature descriptor $f_c(I_k)$ is expressed by:

$$f_c(I_k) = \{(\overline{c}_{k1}, p_{ki}), (\overline{c}_{k2}, p_{k2}), \ldots, (\overline{c}_{kN_k}, p_{kN_k})\}$$

wherein k is a positive integer indicating a serial number of each region, $\overline{c}_{ki}$ is an i-th representative color vector of a k-th region $i = (1, 2, \ldots, N_k)$ ~~$(i = 1, 2, \ldots, N)$~~, p_{ki} is a percentage of the i–th color representative color vector in the k-th region, and N_k is the number of the representative color vectors in the k-th region.

12. (original): The method of claim 8, wherein indexing the feature vector space comprises:

assigning a plurality of representative colors to a plurality of grid points in a color space having a grid structure; and

storing the result of the assignment as a table in a database.

13. (original): The method of claim 11, wherein the color distance between each color vector of each region of the query image and each color vector of each region of each data image is calculated using:

$$d_c(I_1, I_2) = \sum_{i=1}^{N_1} p_{1i}^2 + \sum_{i=1}^{N_2} p_{2i}^2 - \sum_{i=1}^{N_1} \sum_{j=1}^{N_2} 2a_{1i,2j}\, p_{1i} p_{2j}$$

wherein when T_d is a maximum distance by which a similarity of two colors is determined, α is a predetermined scaling coefficient, $d_{max} = \alpha T_d$, and d_{ij} is the Euclidean

distance $\left\|c_i - c_j\right\|$ between two color vectors c_i and c_j, such that $a_{ij} = 1 - \frac{d_{ij}}{d_{\max}}$ if $d_{ij} \leq T_d$, and $a_{ij} = 0$ if $d_{ij} > T_d$.

14. (original): The method of claim 4, wherein step (a2) uses a Gabor function.

15. (original): The method of claim 14, wherein, in step (a2), the texture vectors of the plurality of sample regions are generated using the Gabor function having N frequency channels and M orientation channels, where N and M are both predetermined positive integers.

16. (original): The method of claim 15, wherein the texture features are expressed by a texture feature descriptor $f_t(I_k)$:

$$f_t(I_k) = \{(m_{k11}, \sigma_{k11}), (m_{k12}, \sigma_{k12}), \ldots, (m_{k1M}, \sigma_{k1M}), (m_{k21}, \sigma_{k21}), \ldots, (m_{kij}, \sigma_{kij}), \ldots, (m_{kNM}, \sigma_{kNM})\}$$

wherein m_{kij} is a mean value of a plurality of pixel values of the i-th frequency channel and the j-th orientation channel for a sample region I_k, and σ_{kij} is a deviation of the pixel values of the i-th frequency channel and the j-th orientation channel for the sample region I_k.

17. (currently amended): The method of claim 16, wherein, in step (a2), the texture distance between each color vector of each region of the query image and each color vector of each sample region of each data image is calculated using:

$$d_t(I_1, I_2) = \sum_{i=1}^{N} \sum_{j=1}^{M} \left| \frac{m_{1ij} - m_{2ij}}{\sigma(m_{ij})} \right| + \sum_{i=1}^{N} \sum_{j=1}^{M} \left| \frac{\sigma_{1ij} - \sigma_{2ij}}{\sigma(\sigma_{ij})} \right|.$$

where $\sigma(m_{ij})$ is the standard deviation of the mean value for a color vector for a region of the i-th frequency channel and j-th orientation channel, and where $\sigma(\sigma_{ij})$ is the deviation of the standard deviation of the color vector for a region of i-th frequency channel and the j-th orientation channel.

18. (original): The method of claim 3, wherein step (pa-2) comprises:

(pb-1) obtaining a grid map of the query image and each data image; and

(pb-2) obtaining a texture sample of a desired size for each sample region based on the grid map.

19. (currently amended): The method of claim 18, wherein step (pb-1) comprises:

(pb-1-1) taking a rectangle $M(i, j)$ having largest side lengths for a sample region, wherein $0 \leq i \leq n$ and $0 \leq j \leq m$;

(pb-1-2) dividing the rectangle $M(i, j)$ into a plurality of sub-rectangles each having a $l \times l$ size; and

(pb-1-3) obtaining a grid map for the sample region using a predetermined function which outputs 1 if all the divided grids belong to the sample region, and otherwise, outputs 0, the predetermined function expressed by:

$$M_{grid}(i, j) = \begin{cases} 1 & if\ \ p_{ij}(x, y) \subset I_k\, for \,\forall\, (x, y) \\ 0 & otherwise \end{cases}$$

wherein $0 \leq i \leq \left\lfloor \frac{n}{l} \right\rfloor - 1$ [n/l] being a result of applying the floor function, $0 \leq j \leq \left\lceil \frac{m}{l} \right\rceil - 1$ where [m/l] is a result of applying the ceiling function, $0 \leq x \leq l - 1$, $0 \leq y \leq l - 1$, and $p_{ij}(x, y)$ is a point that belongs to rectangle $M(il + x,\ jl + y)$.

20. (original): The method of claim 19, after step (pb-1-3), further comprising:

(pb-1-4) transforming the grid map obtained in step (pb-1-3) to a grid distance map by repeating computations with:

$\{M^d_{grid}(i,j)\}_0 = M_{grid}(i,j), \textit{ and}$

$\{M^d_{grid}(i,j)\}_n = \min(\{M^d_{grid}(i,j-1)\}_{n-1}, \{M^d_{grid}(i-1,j)\}_{n-1}, \{M^d_{grid}(i,j+1)\}_{n-1}, \{M^d_{grid}(i+1,j)\}_{n-1}) + 1,$

$\textit{if } \{M^d_{grid}(i,j)\}_{n-1} = \{M^d_{grid}(i,j)\}_n, M^d_{grid}(i,j) = \{M^d_{grid}(i,j)\}_n$, and

(pb-1-5) performing region growing in every direction from a seed of the grid map, which has the largest distance in the grid and is expressed by $(a,b) = \underset{(i,j)}{\arg\max}\ \{M^d_{grid}(i,j)\}$, to satisfy the relation $M^d_{grid}(i,j) > 0$ until a maximum area rectangle is extracted.

21. (original): The method of claim 20, further comprising fitting the maximum area rectangle extracted in step (pb-1-5) to the desired size of the texture sample by wrapping.

22. (original): The method of claim 20, further comprising fitting the maximum area rectangle extracted in step (pb-1-5) to the desired size of the texture sample by mirroring.

23. (original): The method of claim 3, wherein step (b) comprises:

(b-1) placing each of the color distances and the texture distances in a 2-dimensional vector space, each vector space defined by the respective distances and associated predetermined weighting factors; and

(b-2) projecting the result of the placement onto the 2-dimensional vector spaces onto a 1-dimensional distance space based on the human visual perception mechanism.

24. (original): The method of claim 2, wherein the predetermined weighting factor to the color distance is determined based on a distribution of representative colors.

25. (original): The method of claim 23, wherein the predetermined weighting factor to the color distance is determined by:

$$\omega_c = 1 - \sum_{i=1}^{N} p_{qi} \log_{10}\left(\frac{1}{p_{qi}}\right)$$

wherein p_{qi} is a percentage of an i-th representative color of one of the first regions of the query image.

26. (currently amended): The method of claim 23, wherein each texture distance is defined by:

$$d_t'(I_q, I_1) = a^{\left(\frac{A(s)}{A(I_1)} + (count(I_1) - 1)\right)} d_t(I_q, I_1)$$

wherein I_q denotes the query image or each first region of the query image, s denotes a sample region of a desired size, $A(\cdot)$ denotes the area of the sample region of the desired size, $count(\cdot)$ is the number of wrappings done to obtain the sample region of the desired size, and a is a constant, and where $d_t(I_q,I_1)$ is a distance function for two images based on their texture vectors.

27. (original): The method of claim 23, wherein the predetermined weighting factor applied to each texture distance is determined based on an area of an initial sample region extracted from the query image and the area of a sample region extracted from each data image.

28. (original): The method of claim 27, wherein the predetermined weighting factor applied to each texture distance is determined by:

$$\omega_t = \frac{1}{a^{\left(\frac{A(s)}{A(I_q)} + (count(I_q)-1)\right)}}$$

wherein I_q denotes the query image or each first region of the query image, s denotes a sample region of a desired size, $A(\cdot)$ denotes the area of the sample region of the desired size, $count(\cdot)$ is the number of wrappings done to obtain the sample region of the desired size, and a is a constant.

29. (original): The method of claim 23, before step (b-2), further comprising normalizing each of the color distances and the texture distances.

30. (original): The method of claim 29, wherein normalizing each of the color distances and the texture distances is performed using a Gaussian normalization.

31. (currently amended): The method of claim 30, wherein normalizing each of the color distances and the texture distances comprises:

wherein v_k is a Gaussian sequence, performing a normalization within a range of [-1, 1] using $v_{m,k} = \frac{v_{\cancel{m,}k} - \mu_k}{3\sigma_k}$ based on a mean value μ_k and a deviation σ_k of the sequence v_k; and

mapping the result of the normalization into a range of [0, 1] using

$$v'_{m,k} = \frac{v_{\cancel{m,}k} + 1}{2}.$$

32. (original): The method of claim 31, wherein normalizing each of the color distances and the texture distances comprises normalizing the texture distances by updating the mean value μ_t and the deviation σ_t of the texture distances by excluding a largest texture distance until the condition of $k \times \frac{\mu_c}{\sigma_c} \leq \frac{\mu_t}{\sigma_t}$, wherein k is a constant, is satisfied.

33. (currently amended): The method of claim 23, wherein step (b-2) comprises projecting the color distances and the texture distances onto a 1-dimensional distance space using:

$$d(I_q,I_1) = W_c d_c(I_q,I_1)\left(1+\frac{2}{\pi}\tan^{-1}\frac{d_t'(I_q,I_1)}{d_c(I_q,I_1)}\right) + W_t d_t'(I_q,I_1)\left(1+\frac{2}{\pi}\tan^{-1}\frac{d_c(I_q,I_1)}{d_t'(I_q,I_1)}\right)$$

[where $W_c = \frac{\varpi_c}{\varpi_c + \varpi_t}$, and $W_t = \frac{\varpi_t}{\varpi_c + \varpi_t}$]

wherein $W_c = \frac{w_c}{w_c + w_t}$, and $W_t = \frac{w_c}{w_c + w_t}$ and where $d'_c(I_q, I_1)$ and where $d'_t(I_q, I_1)$ represent normalized distance functions for two image regions based on their color and texture vectors, respectively.

34. (new): The method according to claim 1, wherein the predetermined weighting factor applied to said each texture distance is determined based on an area of an initial sample region extracted from the query image and an area of a sample region extracted from each data image.

35. (new): The method according to claim 34, wherein said combining of the one or more weighted color distances and the one or more weighted texture distances comprises weighing the one or more weighted color distances and the one or more weighted texture distances with differing weighing factors, said variation of the weighting factors reflect the human visual perception attributes.